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Specification and Drawings, as originally filed, with Application for Patent Serial No: 2,193,909, on December 24, 1996, by NEONICS TECHNOLOGY INC., assignee of Peter R. Mignault, for "Ground Fault Detector for Gas Discharge Tubing".

Agent certificateur/Certifying Officer

August 5, 1997
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Ottawa Hull K1A 0C9

(21) (A1) 2,193,909
(22) 1996/12/24
(43) 1998/06/24

(51) Int.Cl.[6] H02H 3/16

(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Ground Fault Detector for Gas Discharge Tubing

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(57) 9 Claims

Notice: This application is as filed and may therefore contain an incomplete specification.

ABSTRACT

A ground fault detector for detecting a ground fault in an A.C. system including a power transformer having output secondary windings. The detector is comprised of appratus for generating an isolated low voltage D.C. potential between ground and the secondary windings, apparatus for determining if a resistive leakage path is present between ground and a voltage output from the secondary windings, and shut-down apparatus for disconnecting the voltage output.

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Ground Fault Detector For Gas Discharge Tubing

FIELD OF INVENTION

The present invention relates to a structure and method for preventing excessive ground fault cuttents from the high voltage secondary output of a gas discharge lamp driving circuit.

BACKGROUND OF THE INVENTION

With most electronic high voltage ballasts the voltages produced constitute a substantial fire hazard to any return path to ground near the ballast or gas discharge tube installation. To alleviate this problem methods of shutting off the high voltage output have been devised. One of the conventional ways of accomplishing this has been monitoring of the A.C. current in the high voltage secondary center tap being returned to ground. In the event either high voltage lead is conducting to ground causing current to flow from center tap to ground, a current transformer reflects this back to a shutdown circuit. Examples of this can be seen in US patent numbers 4,663,571 by Nilssen and both US patent numbers 4,613,934 and 5,089,752 by Pacholok. This works well in practice only if the load across the high voltage terminals is balanced.

Since most solid state ballasts run at switching frequencies of 10 kHz and above, a secondary return path to ground is that of radiated energy, acting much like a radio frequency transmitter. This return energy is purely capacitive to ground. The result is that if both high voltage leads (antennas) and load do not balance capacitively, a current will flow through the high voltage center tap to ground, creating a voltage across the current sense transformer. The result is a false shutdown.

Another approach is to use the inherent phase shift of 90 degrees between current and voltage when the high voltage is radiated to ground, versus no phase shift if high voltage is conducted resistely to ground. This works, but a phase discriminator circuit is costly and has a high parts count. Based on the background outlined above, subject invention relates to a very cost effective means of providing a function substantially equivalent and with great reliability.

SUMMARY OF THE INVENTION

To overcome the shortcomings of the prior art described above, and to overcome other shortcoming of the prior art that will be understood by one skilled in

the art upon reading and understanding the present specification, the object of this invention is to provide a reliable and cost effect means of disabling a ballast's high voltage output in the event a resistive leakage path to ground should occur, i.e.arcing, while not disrupting normal function of said ballast in the event radiated imbalances (capacitive) to ground occurred, which would lead to false triggering other approaches. As will be appreciated, providing reliable ground fault protection is a highly desirable safety feature, as the most likely path for lethal current would be to ground. Therefore the described method operates even in an environment of secondary imbalances without giving false readings, hence producing a very reliable and suitable cost effective means of accomplishing this goal.

In accordance with an embodiment of the invention, a ground fault detector for detecting a ground fault in an A.C. system includes a power transformer having output secondary windings, the detector comprising means for generating an isolated low voltage D.C. potential between ground and the secondary windings, means for determining if a resistive leakage path is present between ground and a voltage output from the secondary windings, and shut-down means for disconnecting said voltage output.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood by way of the following detailed description of a preferred embodiment with reference to the appended drawings, in which:

Figure 1 is a schematic block diagram of a ground fault detector circuit according to the preferred embodiment; and

Figures 2 and 3 schematically illustrate the preferred embodiment of the invention, showing the ground fault detect circuit adapted to the high voltage secondary winding of an electronic ballast which is connected to a high voltage inert gas discharge tube/lamp such as one filled with neon or a combination of argon with mercury.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following description of the preferred embodiment, reference is made to the accompanying drawing which form part hereof, and in which is shown by way of illustration a specific embodiment in which the invention may be practiced. This embodiment is described in sufficient detail to enable those skilled in the art to make and practice the invention, and it is to be understood that other embodiments may be utilized and that structural, electrical, or logical changes may be made without

departing from the scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the appended claims.

With reference to Figs. 1, 2 and 3, the ground fault detector circuit according to the preferred embodiment will now be described. This circuit respects UL2161 standard, which states that a high voltage return path to ground in excess of 15 milliamperes should shut down a neon power supply. The preferred embodiment therefore should have component values chosen to enable the invention to detect if ground fault current reaches specifically 15 milliamperes. The ground fault circuit is for the purpose of preventing abnormal leakage currents from a resistive return path, e.g. resulting from a dielectric breakdown, e.g. arcing in a high voltage secondary winding to ground, which creates an opportunity for fire hazard. This circuit employs the use of a center tap on an isolated high voltage secondary winding of a loosely coupled transformer.

This center tap point is maintained at a low potential with respect to ground and can be used as an input point for injecting a low D.C. voltage to bias the entire secondary winding either positive or negative with respect to ground. This differential in D.C. voltage between the secondary winding and ground can be used to produce an offset current in the ground fault circuit example described herein, in the event of a resistive leakage path occurring between the secondary outputs and ground.

It should be noted that in the preferred embodiment, the D.C. leakage current is proportional to the respective A.C. leakage current on V1 and V2. This is due to the fact that D.C. offset voltage on the secondary winding is proportional to the A.C. output voltage, thus if the A.C. output voltage increases or decreases the D.C. bias voltage on the secondary winding will change proportionally. This change will emulate the effective A.C. leakage current value as seen through a resistive path to ground.

Diodes D1 and D2 cathodes are tapped on the secondary at points A and B. This is used to monitor a small representative portion of the high voltage output produced at V1 and V2. D1 and D2 are then used to rectify this sample point voltage into D.C. component to charge C1 through a series limiting resistor R1. The tap points A and B are chosen so as to produce approximately 25 volts D.C. across C1 when V1 and V2 are at their maximum AC output. C1 positive is then used to provide a positive bias

back to the secondary center tap via R1 when referenced to C1 negative which is normally at ground potential. C2 positive is connected to A.C. ground and C2 negative is connected to C1 negative. This provides an A.C. return path to ground to maintain a low A.C. potential from the secondary center tap via the return path R1, C1, C2, and R2 to ground. Normally, at this point, C2 should have no net D.C. component unless a resitive return path occurs between the high voltage winding and ground (C2+). If a resistive return path occurs, C2 will begin to charge. R2 is added in parallel with C2 to set the voltage on C2 for a given D.C. leakage current.

A series limiting resistor R3 connected between ground and U1 reference input is used to monitor the D.C. potential at ground. The anode of U1 is connected at C1 & C2 negative and is used to monitor any D.C. offset voltage generated across C2 and R2. U1 is a programmable shunt regulator. Functionally it is similiar to an NPN bipolar transistor in operation, except that the threshold voltage to turn on the shunt regulator is 2.5 volts from anode to reference input.

When the voltage differential across the anode to reference of U1, (as sampled across C2, R2, and series limiting resistor R3) exceeds 2.5 volts U1 will turn-on from anode to cathode. This will cause current to flow from bias capacitor C1 positive through series limiting resistor R4 and through the photo diode of opto-coupler U2, and back to the cathode of U1, through U1 to it's anode and back to C1 negative.

This current path through U2's photo diode will illuminate the photo diode causing U2's photo transistor to go into a low resistance state, which is used to trigger a shut down in the inverter block. R5 is added across U2's photo diode to prevent it from turning on as a result of U2's anode to cathode leakage current. D5 is added across U2 to prevent photo diode damage from reverse voltage spikes. D4 is added across U1 to protect the reference input from reverse voltage spikes. D3 is added across U1 to protect the anode/cathode from reverse voltage spikes. D3 is also used in this to act as a limiting shunt in the event secondary voltage goes too high. This is used to trigger an inverter shutdown in the same way as if U1 had turned on from ground fault currents. This also provides the inverter with open circuit monitoring of the high voltage secondary windings.

I claim:

1. A ground fault detector for detecting a ground fault in an A.C. system including a power transformer having output secondary windings, the detector comprising means for generating an isolated low voltage D.C. potential between ground and the secondary windings, means for determining if a resistive leakage path is present between ground and a voltage output from the secondary windings, and shut-down means for disconnecting said voltage output.

2. A very accurate current sense threshold can be chosen due to the fact that the D.C. offset potential produced is proportional to the A.C. voltage produced and a well defined value of leakage can be established for accurate value threshold signals.

3. A circuit that complies with UL2161 ground fault shutdown for electronic ballast that power gas discharge tubes, which was published on September 30, 1996.

4. A ground fault detection circuit whereby a D.C. bias voltage is applied to an isolated high voltage winding with respect to a ground point.

5. A ground fault detection circuit whereby a D.C. offset is created when a resistive leakage path occurs between a D.C. biased high voltage winding and a ground point.

6. A ground fault detection circuit whereby a trigger signal is generated when a D.C. current flows from a D.C. biased winding to ground, caused by a resistive leakage path between the D.C. biased winding and ground.

7. A ground fault detection circuit whereby the means of detecting a leakage current to ground is by the creation of, and the detection of, a D.C. potential across a high voltage winding to ground.

8. A ground fault detection circuit whereby the D.C. leakage current path from a D.C. biased high voltage winding to ground can be used to extrapolate the amount of A.C. leakage is present across the resistive leakage path between the high voltage winding and ground.

9. A ground fault detection circuit that complies with the requirements of UL2161 ground fault shutdown for high frequency electronic power supplies for use with luminous tubular glass signage (e.g. neon or argon/mercury filled gas discharge tubes) of the type often found in connection with retail advertising and decorating.

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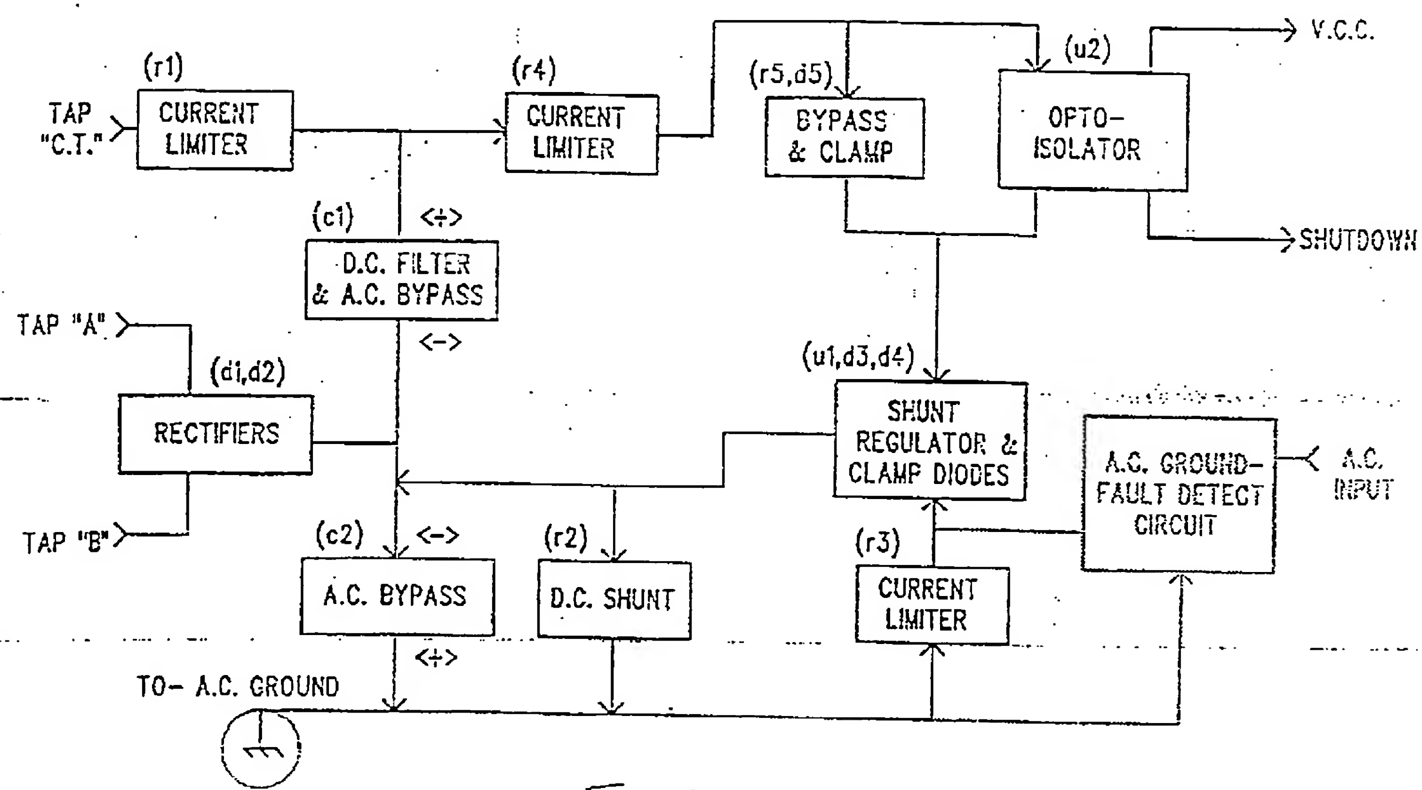

Fig. 1

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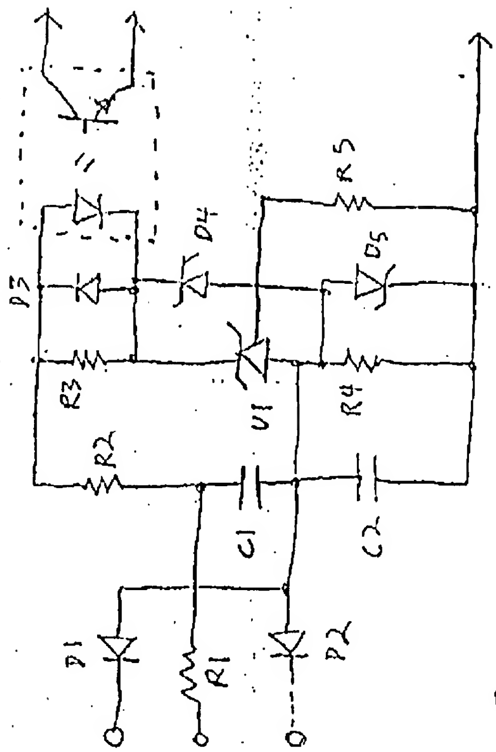

Fig. 2

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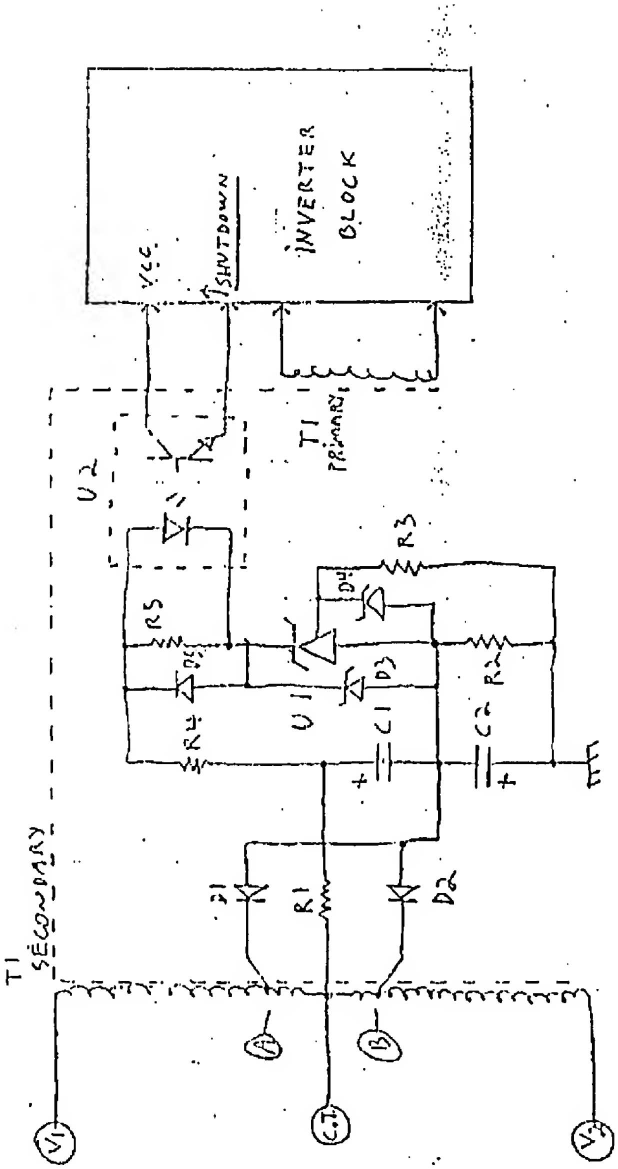

Fig. 3